



The Single Aperture Far Infrared Telescope (SAFIR)

Making Dreams Come True

*Dan Lester, University of Texas
June 2004*

*"From Spitzer to Herschel and Beyond:
The Future of Far -IR Space Astrophysics"*



SAFIR - A Probe of Cosmic Beginnings

“To take the next step in exploring this important part of the spectrum ...”

2000 NRC Decade report

-
- Resolve the FIR background - trace star formation to $z > 5$
Astrophysics at the most active epoch
 - Probe the earliest epochs of metal enrichment
Structure of the galaxy-forming universe before metals
 - Track the chemistry of life in the warm cosmos
Prebiotic molecules from clouds to planets
 - Identify nascent solar systems from debris disk structure
Birth of planetary systems

This is YOUR observatory



SAFIR - Value to NASA and the Community

“... a single 8-10 meter telescope operating in the far IR could serve as a building block for the Life Finder, while carrying out a broad range of scientific programs beyond JWST and SIRTf.” 2003 Origins Roadmap

- Scientific successor to Spitzer, Herschel, and SPICA
Promotes rich set of mission opportunities (e.g. SPECS)
- Powerful scientific partner to JWST, SOFIA and ALMA
- Commonality in technology needs with many missions
clear path to large science arrays
enabling new spectrometer architectures
demonstrated command of passive cooling
cryocooler advances
deployable large aperture advances

Huge science need coupled with feasibility



Flowdown to Mission Concept

What SAFIR is ...

Aperture	~10m	high-z galaxies, debris disks
Temp	<15K	L* galaxy @ z=5 zodi-limited operation
λ range	20-500 μ m	primary coolant lines chemistry, structure diagnostics peak of early galaxy SED
Spatial res	2" @ 100 μ m	proto-planetary disks, early galaxies, bulge/disk fmtn
Lifetime	>5 years	productivity

Clear paths to realizing the requirements



SAFIR Vision Mission Study

A strategic planning tool for the future

- Funded by NASA OSS 4/04, 1-year study effort

- PI Dan Lester, 14 Cols, 9 collaborators

Andrew Blain

Dominic Benford

Matt Bradford

Mark Dragovan

Bill Langer

Charles Lawrence

David Leisawitz

John Mather

Lee Mundy

Harvey Moseley

George Rieke

Gordon Stacey

Hal Yorke

Erick Young

- Involvement of 4 NASA centers

GSFC, JPL (co-lead centers),
MSFC (SOMTC), JSC (Exploration)

Al Nash, JPL
Keith Walyus, GSFC

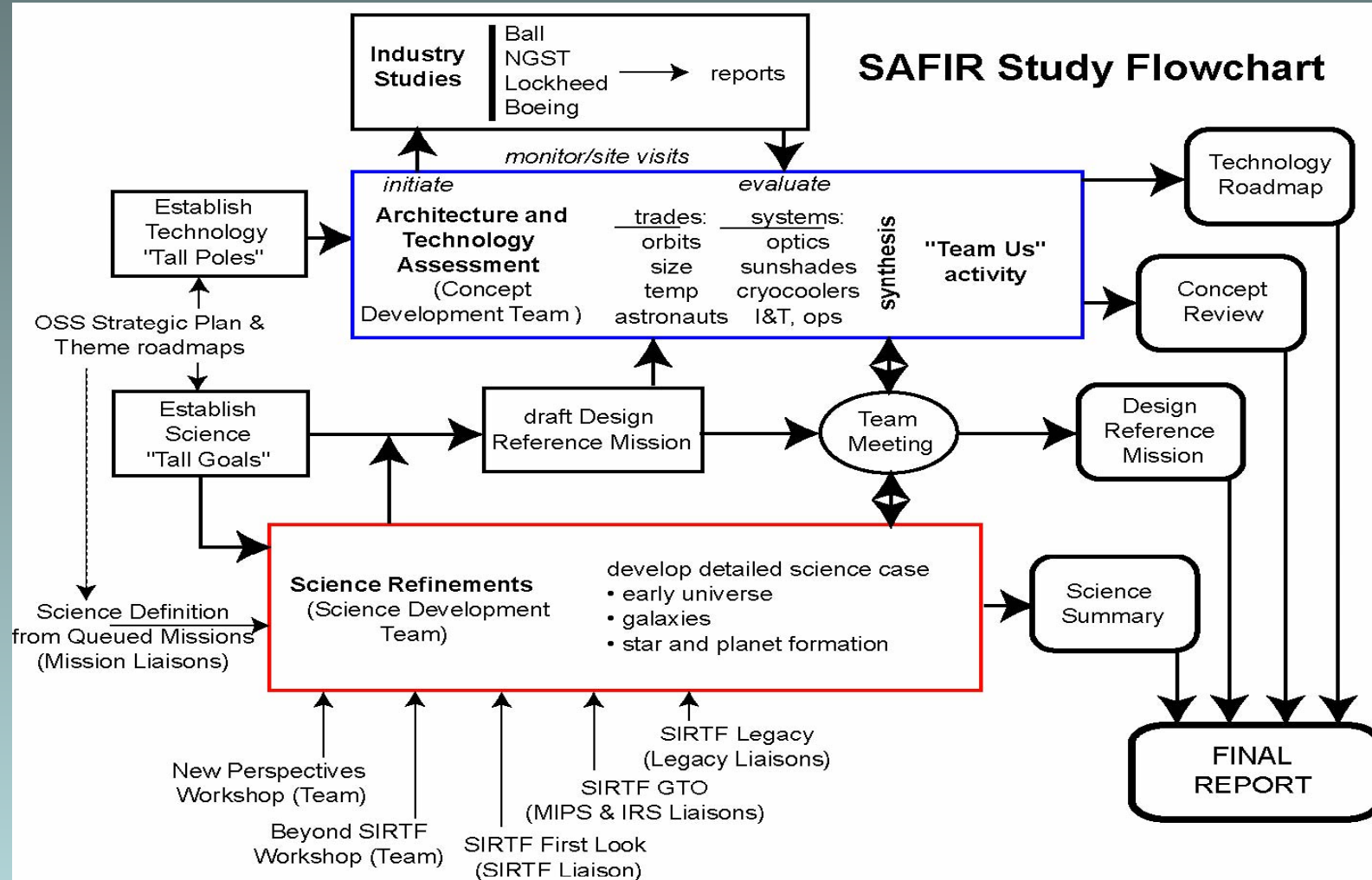
Phil Stahl, MSFC
Brenda Ward, JSC

- Contributions from 4 key aerospace contractors

Ball, Boeing, NGST, Lockheed-Martin

Building close partnership on FIR space astronomy

SAFIR Vision Mission Study Schedule Plan





SAFIR Vision Mission Study

Products and Considerations

- Science Summary - “Tall Goals”
- Design Reference Mission
- Technology Assessment - “Tall Poles”
SAFIR technology roadmap
- Architecture Options
industry studies, key trades,
human/robotic opportunities
- “Team-Us” integrated design study
(JPL Team X review with participation
by key 2003 GSFC IMDC review staff)

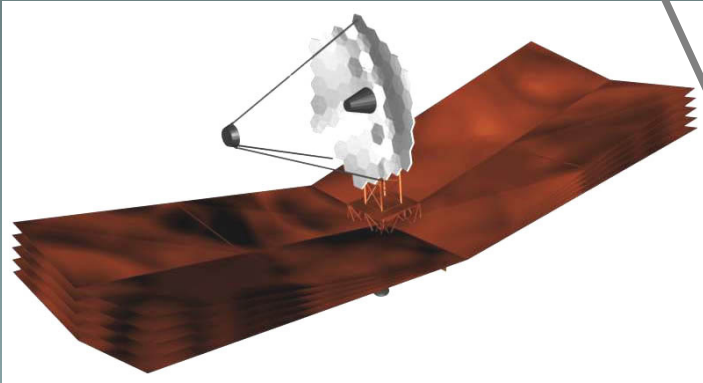
Spitzer science results
Herschel, JWST technology
Exploration Initiative

Formal case for goals-compliant and achievable SAFIR



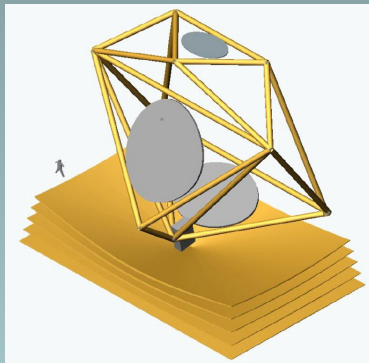
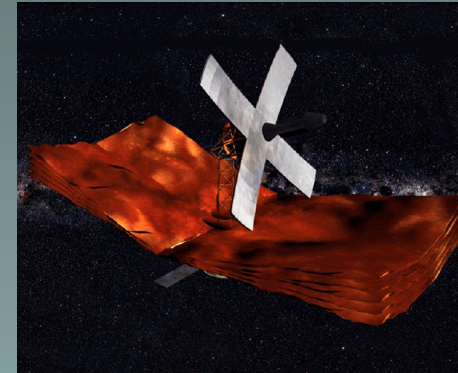
Flavors of SAFIR

Architectures of value to space FIR



- JWST-like
max system validation

- sparse aperture
max baselines
deployment simplicity



- “DART” w/ membrane mirrors
large aperture/weight ratio

*commonality in technology needs
among these and other OSS missions*

→ deployment, active surface control
→ large format, low noise detectors

→ cryocoolers, thermal management
→ large, lightweight optical structures



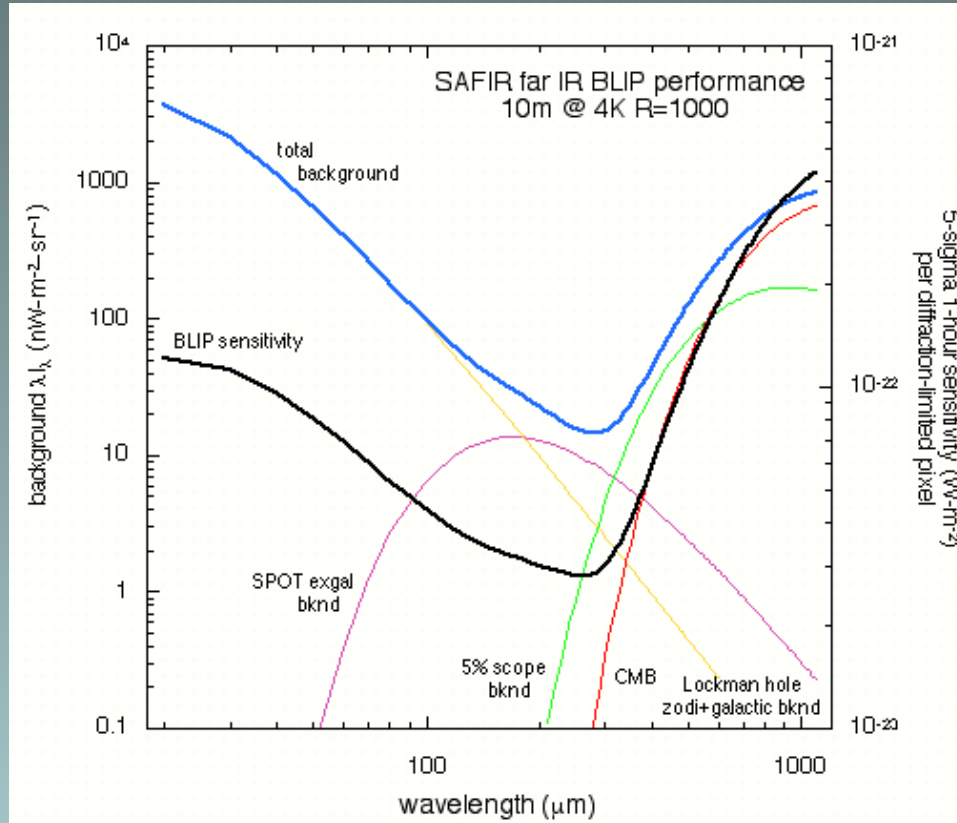
Critical Thermal Technologies And Key Trades for SAFIR

- Cryogenic, deployable large apertures
 - actuators, latches
 - lightweight mirror substrates
- Optimized background reduction strategies
 - shield architectures
 - low emissivity designs (off-axis?)
 - field of regard versus insolation
 - orbit (L2, drift-away, out of plane, distant?)
- Cryocoolers
 - shield cooling (gas flow, capillary technologies)
 - ACTDP extension (100mW @ 4K)

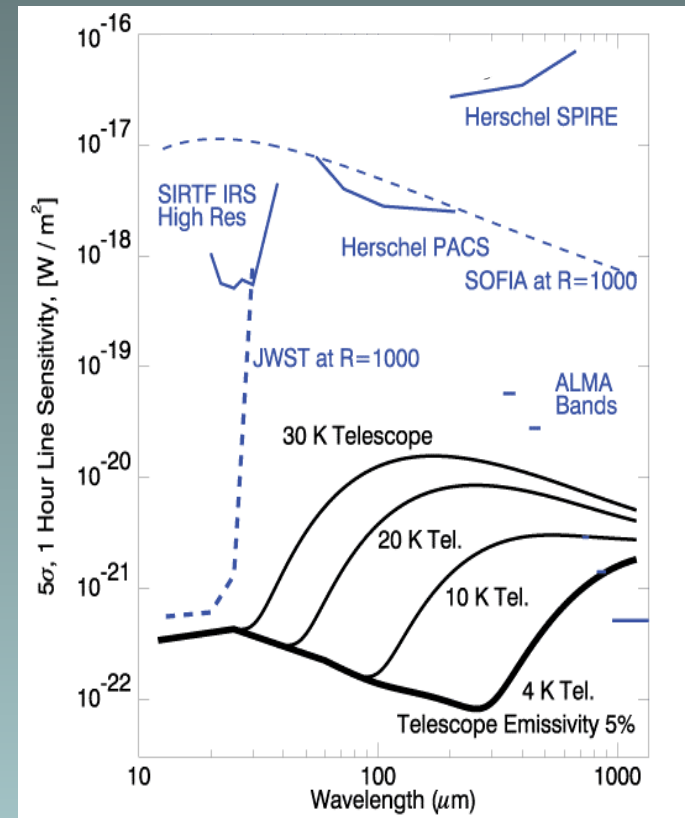
State of Art suggests cosmic BLIP is achievable!



Components of the Background



Sky background



Telescope background

FIR sensitivity needs drives thermal requirements



Critical Focal PLane Technologies And Key Trades for SAFIR

- Compact, efficient spectrometer architectures
- Large format (10^3 - 10^4) broadband arrays
 - semi- and superconducting (TES) bolos
 - Ge, Si BiB photoconductors
- Quantum noise-limited heterodyne spectrometers
- Low power dissipation and thermally isolated focal plane arrays and instruments
 - cryogenic mpxrs
 - superconducting electronics

FIR focal plane tech investments offer big payoff



New Science Opportunities Identified by Spitzer

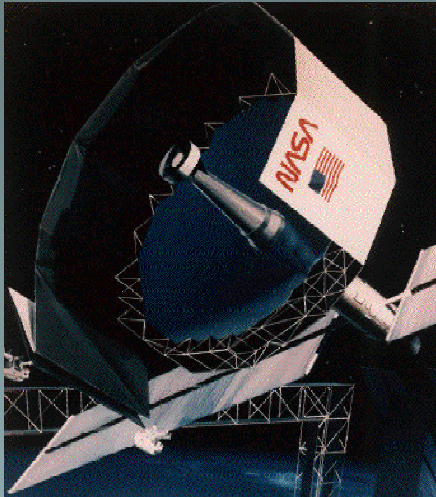
At least one challenge for SAFIR definition is *prompt harvest and digestion* of Spitzer science surprises.

- Heating mechanism of cold dust and importance of PAHs in galaxy energetics.
- Clear discrimination between AGNe and starbursts.
- Morphology of dust in debris clouds. Reconciliation of lobed structure at mm wavelengths with mid-IR.
- tbd ...

Designing SAFIR to build on Spitzer (& etc.) results.



Special Trades



Consistent with the new NASA Space Exploration initiative, the SAFIR study will consider enabling opportunities that could be brought by humans and or robots. Strategic alignment with Space Architect's office.

SAFIR as a test template for large astronaut-aided science facilities in space. Strong Code T & Code S interest. JSC Code EX to oversee efforts in a responsible way. NExT heritage.

- Construction/Deployment?
- I&T/system validation?
- Servicing?

Enabling opportunities for astronomy in the new NASA?



the road ahead

- completion of SAFIR Vision Mission Study
- 2005 OSS Strategic Planning
- ST-9 technology demo mission (2008)
- next NRC Decadal Survey (kickoff 2008)
- evolution of Exploration Initiative ...

Consensus on, and good articulation of, priorities by our community is
important factor in our success.